Memoirs ... England and Wales.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

GREAT BRITAIN,

AND OF THE

MUSEUM OF PRACTICAL GEOLOGY.

THE IRON ORES OF GREAT BRITAIN.

PART II.

THE IRON ORES OF SOUTH STAFFORDSHIRE.

[District memoirs: Iron ores of Great Britain]

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF
HER MAJESTY'S TREASURY.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY
LONGMAN, BROWN, GREEN, LONGMANS, AND ROBERTS.

1858.

NOTICE.

The Session of the Government School of Mines and of Science applied to the Arts commences early in October in each year, during which the following Courses of Lectures are delivered:—

Chemistry, with special reference to its applications in the Arts and Manufactures - - -	A. W. Hofmann, LL.D., F.R.S.
General Natural History - -	T. H. Huxley, F.R.S.
Physics - - - -	G. G. Stokes, M.A., F.R.S.
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The Chemical Laboratory, under the direction of Dr. Hofmann, and the Metallurgical Laboratory, under the direction of Dr. Percy, are open for the instruction of Students.

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Jermyn Street, London. S.W.

NOTICE.

A new Edition, with Additions and Corrections, of Part 2. of Vol. I. of the Records of the School of Mines, containing Mr. Jukes's Memoir on the Geology of the South Staffordshire Coalfield, is in the press, and will be published shortly.

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In issuing the Second Part of the Memoir on the Iron Ores of Great Britain, comprising those of South Staffordshire, it is necessary to explain that, although the analyses have long been prepared, it became essential to the completion of the work, that Mr. Jukes should revisit a district in which many new mining operations have laid open phenomena previously unknown; but the onerous duties of Mr. Jukes in Ireland as Local Director of the Geological Society have hitherto interfered with his performance of this special duty. The Third Part of this Memoir will shortly appear.

RODERICK I. MURCHISON,
Director General.

November 1858.

CONTENTS.

PART II.

Iron Ores of the South Staffordshire Coal Field.

General Description. (By J. Beete Jukes, M.A., F.R.S.)

1. *External Appearance of the Iron District.*

A general account of the geology of the South Staffordshire coal field will be found in the Records of the School of Mines, vol. I., part 2., in which a description is given of the geological survey executed on part of the ordnance maps 62 N.W. and S.W. and 54 N.W. These maps were accompanied by 3 sheets of vertical sections, Nos. 16, 17, and 18, and three sheets of coloured longitudinal sections, Nos. 23, 24, and 25. The publication of the analyses of some of the iron ores of the district under the direction of Dr. Percy, at the instance and chiefly by the liberality of Mr. S. H. Blackwell, renders it advisable to make an abstract of the memoir mentioned above, with especial reference to the iron stones contained in the district.

The seat of the great iron manufacture of South Staffordshire is not co-extensive with the whole of that coal field, nor is it ever perhaps likely to become so, since it is the middle part only of the coal field which has ever been largely productive of ironstone. If we take the town of Dudley* as a centre, and draw a northern boundary line from Wolverhampton through Bloxwich to Walsall and a southern boundary line from Stourbridge to Halesowen, connecting Stourbridge with Wolverhampton on the west side, and Halesowen with Walsall on the east side, we shall include nearly the whole of the great iron-making area, great in results rather than in geographical extent. This area will

* Dudley is legally in Worcestershire, there being several large, and a multitude of small, isolated patches of Worcestershire which are enclosed within the boundaries of Staffordshire. One considerable piece of country around Halesowen is similarly reputed to be in Shropshire, though separated by many miles from any other part of that county.

approach in form to a parallelogram, 10 miles long from N.N.E. to W.S.W. and 5 miles wide from E. to W., containing therefore about 50 square miles.

There is hardly perhaps to be found anywhere in the world another space of 50 square miles of so peculiar a character. It is commonly known in the neighbourhood by the name of the "black country," an epithet the appropriateness of which must be acknowledged by every one who even passes through it on a railway.

Huge "spoil banks" of black shale, great mounds of rough slag and heaps of cinders and refuse of all descriptions, surround numbers of dark and massive smelting furnaces, puddling furnaces, rolling mills, and other huge structures for the smelting or the manufacture of iron. Flames and smoke are ceaselessly belched forth from their summits, while from their murky recesses break forth dazzling rays of light emitted by the surface of molten iron through half open furnace doors, or millions of brilliant sparks starting from glowing lumps at each blow of the forge hammer. Half naked figures may be seen trailing along fiery masses or passing them backwards and forwards between rollers which squeeze them, as if they were phosphorescent wax, into bars or rails or rods, or into thick wires spouting into the air and twining along the ground like snakes of fire.

Around these cyclopean dens are innumerable coal pits, with their engine houses and their creaking machinery for pumping and winding; large "coke hearths" with their smouldering heaps; and great stacks of coal and iron ready for transport along the net-work of canals and railways and tramways that ramify in every direction among them.

Quarries and "open works," sand pits, clay pits, and brick-kilns contribute to the apparent disorder of the scene; the surface of the earth seeming to be of use chiefly as a place whereon to manipulate the matters extracted from its interior.

Rows and clusters of small brick houses cover the whole country, connecting seven important towns* and sixteen large

* Wolverhampton, Bilston, Darlaston, Wednesbury, Walsall, Dudley, and Stourbridge.

villages which in other districts would be called towns,* so that in most cases it is not very easy to say where one town or village ends and another begins. The peculiarity of the scenery is increased by the occasional appearance of houses, and sometimes of large buildings and high chimneys, slanting considerably from the perpendicular, in consequence of the sinking in of the ground on which they stand, while the same cause produces unnatural-looking hollows, filled sometimes with shallow pools of water, spreading here and there over the surface. The canals and railroads for the same reason require constant watching, and frequent repairs and additions to their sides and embankments to keep them up to their original level. If we add to these strange features clouds of dense smoke and black dust, and imagine the perpetual creaking and clanking of chains and machinery, the panting and shrieking of steam engines, the continual thumping of forge hammers, and the everlasting bellowing of blast furnaces, we shall complete a picture calculated to astonish, if not perhaps to affright and disgust, the quiet inhabitant of a secluded rural district.

To the student of social or political science, however, to one who would anatomise the body politic and make himself acquainted with the structure of the hidden nerves and arteries, the muscles, bones, and sinews on which the strength and greatness of our country depends, such a district has an interest which soon overpowers this disgust. Nor should even the poet or the painter turn from it with disdain. It contains the elements of a certain kind of grandeur, if it be devoid of elegance or beauty. Let such an one witness the tapping of a smelting furnace on a winter's evening when the stream of liquid iron spreads into small glowing pools of fire, lighting up with an intense brilliancy the black masses of brickwork and snow-capped roofs around, and watch the play of light and shade and many tints of colour, as the white light from the molten iron changes into orange,

* Wednesfield, Bloxwich, Willenhall, Sedgley, Coseley, Tipton, Great Bridge, West Bromwich, Oldbury, Gornal, Netherton, Brierly Hill, The Lye, Cradley, Halesowen, and Rowley Regis.

and then slowly deepens into red. Or let him, after reading Milton's description of Pandemonium, take his stand on any of the eminences near Dudley, between six and eight o'clock of a clear dark night, and look over the surrounding country, lit up with fires and flames of every hue and every shade of brightness, fire beyond fire, over miles of ground on each side of him, and let him listen to the mingled hum and roar and shriek, that comes from near and far to his ears, and he will have presented to his senses a more close approach perhaps to a material representation of the poet's dream than any other spot of this earth can afford him.*

The cause of such an amount and such a concentration of mining and manufacturing industry within the small area mentioned above is the quantity of coal and ironstone to be found within a small vertical subterranean space, the top of that space being also within a very slight depth from the surface. Other coal fields may have beneath the surface a greater total amount of coal, and an equal or perhaps greater amount of ironstone. The beds of coal and ironstone, however, are generally separated from each other by a much greater thickness of other materials (clays, shales, sandstones, &c.) than in the South Staffordshire coal field, and there is thus rendered necessary either a much greater depth in each of the pits, or else a much wider diffusion of those pits over a larger area, in order to hit upon the different beds within a reasonable distance from the surface. In no other coal field of the United Kingdom is a thickness of 30 feet of coal to be found together, while in South Staffordshire 12 or 13 beds of coal rest one upon the other, with but very slight "partings" of shale between them, making up often that thickness and sometimes more.

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* I once lived for some time on the borders of Staffordshire and Shropshire, about six miles from the nearest margin of this coal field, and between it and that of Coalbrokedale in Shropshire. On a dark winter's night, when the clouds were low, both quarters of the heavens were glowing red from the reflection of the fires beneath; and on a still frosty evening, from high ground, the noise of the machinery from the South Staffordshire district could be distinctly heard, something like the distant roar of carriages over a paved street, mingled with a low pulsation of forge hammers.

In the same way I believe the quantity of ironstone to be found in some parts of this district within a vertical space of 100 or 150 yards, is greater than is known anywhere else.

2. *Internal Structure of the South Staffordshire Coal Field.*

The following is a general account of all the beds known in the South Staffordshire coal field, beginning with the uppermost. It must not, however, be supposed that all these beds are to be found vertically one under the other in any one part even of that small area. The uppermost beds of all, are known only in its southern extremity, where the beds dip to the south. Deep sinkings show that the lowest beds are either altogether absent there, or at least no longer contain the coals and ironstones in which they are so rich a few miles farther north. Towards the north, on the other hand, the lower beds " crop out " or rise towards the surface, and it is therefore not possible that the upper beds should be found there. The following section, therefore, is compiled partly from the examination of the southern, partly of the middle, and partly of the northern part of the district, the object being to enumerate every important bed of coal and ironstone, and to show its place relatively to all the others that either do or might occur above and below it.

General Section of the Coal Measures in the South Staffordshire Coal Field.

	Feet.
Beds above the Upper Sulphur Coal - - -	500 to 600
*Upper Sulphur Coal - - - - - -	$1\frac{1}{2}$
Intermediate measures - - - -	about 140
*Little or Two-foot Coal - - - - - -	2
Intermediate measures - - -	varying from 2 to 48
1. Brooch Coal - - - - - - -	about 4
I. Brooch Binds Ironstone measures - - - -	7 to 20
*Herring Coal - - - - - - -	1

* These three coals are not numbered, because they have never been found in a sufficiently good condition to be worth working.

		Feet.
II.	Pins and Pennyearth Ironstone measures*	6 to 30
	Intermediate Measures, containing the Thick Coal Rock (a Sandstone)	38 to 157
III.	†Broad Earth, Catch Earth, and Batt, containing sometimes the Ten Foot and Backstone Ironstones	6 to 14
2.	Thick Coal	30
IV.	Pouncill Batt, Blacktery and Whitery, containing the Grains Ironstone and sometimes the Whitery Ironstone	2 to 8
V.	Gubbin Ironstone, sometimes called the Little or Top or Thick Coal Gubbin, sometimes the Black Ironstone	2 to 8
	Table Batt and intermediate measures	2 to 28
3.	Heathen Coal	about 3
	Intermediate measures (sometimes wanting)	0 to 43
4.	Rubble or Lower Heathen Coal, sometimes when the measures above are wanting, forming the bottom part of the Heathen Coal	2 to 4
	‡Intermediate measures	10 to 33
VI.	New Mine or White Ironstone	2 to 10
VII.	Measures containing Pennystone Ironstone, called also Bluestone or Cakes	10 to 25
5.	Sulphur Coal	2 to 9
	Intermediate measures	2 to 99
6.	New Mine Coal	2 to 11
VIII.	Measures containing the Fire-clay Balls Ironstone occasionally	2 to 40
7.	Fire-clay Coal	1 to 14
	Intermediate measures	2 to 10
IX.	Getting Rock Ironstone (occasional)	4 to 5
X.	Poor Robin Ironstone measures	3 to 5
	Intermediate measures	0 to 9
XI.	Rough Hills White Ironstone (occasional)	2 to 19
8.	Bottom Coal	3 to 12
	Intermediate measures	5 to 30
XII.	Gubbin and Balls Ironstone (or sometimes Bottom or Great Gubbin)	0 to 10
	Intermediate measures	18 to 50
9.	Singing or Mealy Grey Coal	2 to 4
	Intermediate measures	16 to 50
XIII.	Blue Flats Ironstone	2 to 9
	Intermediate measures	10 to 14
XIV.	Silver Threads Ironstone	4 to 7
	Intermediate measures	6 to 15
XV.	Diamonds Ironstone	2 to 3
	Lowest measures	0 to 50

* This measure is rich in the remains of fishes.

† Pronounced Broad Heath and Cat Heath.

‡ About Bentley there is a small ironstone, called Lambstone, 10 feet below the Heathen coal, and three feet under that again is an ironstone called the Brownstone, the total thickness between the Heathen Coal and the New Mine Stone being 32 feet.

The measurements given in the preceding table are the extremes which each set of beds presents at different places; several of them thinning out and ending altogether in some directions. These variations in thickness, however, take place in such a way as generally to balance each other, the mean thickness, for instance, of the whole set from the bottom of the Thick coal to the top of the Blue Flats ironstone is about 320 feet, or 106 yards, over a large space north-west of Dudley, although great changes take place in the thickness of particular sets of beds within that space.

There is apparent, however, a general thickening of the measures as we proceed northwards from Dudley to Bilston and Bloxwich, the distance between the Thick coal and the Blue Flats being only 80 yards at the Foxyards near Dudley, and 90 yards at Bradley, while it gradually increases to 120 and 130 yards about Bentley and Bloxwich, that being the thickness between the Blue Flats and the Bentley Hay coal, which is the representative of the bottom beds of the Thick coal. This thickening, however, is still more remarkable with regard to the Thick coal measures themselves, as the beds of coal which in the central district rest directly on each other are separated by spaces of 60 or 80 feet about Wyrley, the 30 feet of Thick coal in the central district being expanded to about 330 feet of shale, sandstone, and coal in the northern one.

The Blue Flats ironstone itself is scarcely worked south of Bilston, and it is not till we approach Bentley near Walsall that the Silver threads and Diamonds begin to show themselves. North of Bloxwich, on the other hand, although the other beds appear to increase still further in thickness, especially the shales and sandstones, splitting up and separating the coals that were near or close together further south, yet the ironstones, so far as is yet known, appear to diminish and die away altogether, none but a few comparatively poor or lean bands having yet been discovered, either about Wyrley or near the Brown Hills.

Such being the constitution of the beds comprising the coal field, it may be useful to add a few words as to their "position and lie" in the ground.

Commencing at the northern apex of the coal field at Brereton near Rugeley, the Coal Measures appear suddenly at the surface from under the New Red Sandstone, being bounded apparently by two faults that separate wider and wider as they proceed towards the south. These two principal boundary faults are more or less traceable along the whole flanks of the coal field. The beds lying between them seem at first, about Brereton Hayes and Beaudesert Old Park, to dip gently to the east, but after that all over Cannock Chase, and as far south as Bentley, the dip is towards the west, or a little north of west, generally at an inclination of less than 5°. The lower beds rise to the surface accordingly as we approach the eastern boundary fault, the Deep (or Bottom) coal cropping out a little south-east of the Moat near Pelsall, and being traceable at the surface, thence to the neighbourhood of West Bromwich. A little east of a large part of that space, the Silurian rocks which lie below the coal measures crop out, being visible at the surface for nearly five miles, from the north of Daw End to the south of Bustleholm Mill. The measures are much broken by faults, having, generally, a nearly east and west direction, producing up-throws and down-throws to the north or south, and shifting the out-crop of any particular bed to the east and west accordingly. One large up-throw to the south, amounting in some places to a vertical displacement of 360 feet, extends right across the coal field, lifting up the lower measures so as to cause the New Mine coal to crop out all across the district from Bentley to Wolverhampton. South of this great Bentley fault, the beds dip very gently to the south all the way to Tipton, being bent up on both sides of the coal field towards the Dudley and Sedgley anticlinal on the west as well as towards the Walsall district on the east. Between Bilston and Tipton the dip is very slight, but several east and west faults, having a downthrow to the south, contribute to bury the beds deeper in that direction, till we reach the Dudley Port Trough faults, after which the dislocations form upthrows to the south, and bring the beds

nearer to the surface as the ground rises to the Rowley Hills. These hills are capped by basalt, and it is remarkable that, in the angle of the coal field to the south-east of Rowley, all the valuable beds of coal and ironstone seem to be greatly deteriorated, if not destroyed, for some distance, partly by the intrusion of trap rock, but chiefly by what may be called a "congenital malformation," or defect in their deposition; worthless materials taking the place of those which are more valuable. To the south and west of Dudley and Rowley the beds deepen again, both from their own inclination and the effect of the Russell's Hall fault, which is a downthrow to the south-west. This south-west corner of the coal field is partially divided into two basins (which we may call the Pensnett and Cradley basins) by the effect of the Netherton anticlinal. Both these basins are traversed by several faults, and the Netherton anticlinal seems to end suddenly with a high dip to the south, so that the very uppermost beds of the coal-measure series stretch right across the whole district from Kingswinford to Halesowen and the Leasowes. South of this line the whole coal field seems to dip gently and steadily southwards beneath the Permian rocks of the Clent Hills and Frankly Beeches, and the coal measures are no more seen at or near the surface, except in some little shreds and patches on the flanks of the altered Silurian rocks of the Lickey Hills.

3. *Details of the Ironstone Measures.*

It remains now only to give some details on the different beds or sets of beds which contain workable ironstone.

I. "*Brooch Binds*" *ironstone measures.*—The Brooch binds are beds of clay or shale just underneath the Brooch coal. They only contain ironstone to the south-west of Dudley. They average there about 7 feet in thickness, containing nodules of ironstone which are sometimes, but not always, worth getting. This is about Corbyn's Hall and Bromley Hall, and also near Corngreaves. About Brierly Hill and at Wordesley Bank they contain good ironstone, and the "binds" thicken out to 20 feet.

II. "*Pins and Pennyearth" ironstone measures.*—These take their names from the form of the ironstone nodules which they contain, the Pins being small round or cylindrical nodules, and the Pennyearth small flattish nodules like penny pieces. They are found on both sides of Dudley, being spoken of as from 7 to 20 feet thick about Tividale, Tipton, and Oldbury, but are now principally gotten to the south-west about Corbyn's Hall and Brierly Hill, and also near Congreaves. At Wordesley Bank the measures containing the Pins were said to be 4 feet, and those containing the Pennyearth 27 feet.

Mention is occasionally made of ironstone about this horizon even as far north as Bradley near Bilston.

III. "*Ten-foot stone" and "Backstone" ironstone.*—It is, I believe, only about Brierly Hill that these ironstones have ever been found. The Backstone is so called from its lying immediately above, or on the *back* of, the Thick Coal; the Ten-foot stone, from its occurring just ten feet above the Thick Coal.

IV. *The "Grains" and "Whitery" ironstones.*—These are merely occasional ironstones which sometimes occur in beds called "Blacktery" and "Whitery" consisting of dark coloured and light coloured clunch. The beds themselves are sometimes absent altogether, and they never exceed 6 or 8 feet in thickness even when they contain most ironstones.

V. *The "Gubbin ironstone,"* sometimes called the "*Little or Thick Coal Gubbin,*" and sometimes near Dudley known as the "*Black stone,*" is one of the most widely diffused and most exclusively worked of all the beds of ironstone in the coal field. The following is a detailed section of it as it occurred at Upper Gornal, and was noted by Mr. Kenyon Blackwell:—

	Ft.	In.
Ironstone (called Gubbin) -	0	6
Dark Clunch - - -	2	0
Ironstone (called Cannock) -	0	6
Dark Clunch - - -	2	0
Ironstone (called Rubble) -	0	3
Black Batt - - -	0	6
	5	9

The Gubbin measures consist principally of dark clunch, and the stone is usually dark coloured, occurring in either one, two, or three layers of nodules. The total thickness of the whole varies from 2 to 9 feet in different places.

In the district of Bentley near Walsall, and, I believe there only, there occur two small ironstone bands of good quality between Nos. V. and VI. They lie a little below the Heathen Coal, the following being the section supplied by Mr. George of Bentley :—

	Ft.	In.
Heathen Coal - - -	1	8
Clunch and Ironstone - -	9	10
Lambstone (Ironstone) - -	0	3
Clunch - - -	2	6
Black Batt - - -	1	0
Brownstone (Ironstone) - -	0	6
Clunch, Ironstone, and Black Batt -	3	3

This Brownstone is said to resemble the Blackband of Scotland. Neither of these ironstones are known anywhere to the southward of the great Bentley fault.

VI. *New Mine Ironstone or White Stone.*—This is perhaps still more widely diffused and more largely worked than the Gubbin, being known from Bentley on the north to Halesowen on the south, a distance of 10 miles. It is a light coloured ironstone occurring in large nodules lying in a bed of clay which is called "clunch," "clod," or "binds" according to its minor varieties. The layers of nodules vary from 2 to 4, and the whole measure from 2 feet to 10 feet in thickness, the most usual being 4 or 5 feet. The following details will give a good idea of its variations. The places are arranged in order from north to south.

1. *Northern Part of Bentley Estate.*

	In.	Ft.	In.
Ironstone - -	3	0	3
Clunch - - - -		0	7
Ironstone - -	4	0	4
Clunch - - -		3	3
Ironstone - -	4	0	4
	11	4	9

2. *Chillington Colliery near Wolverhampton.*

	In.	Ft. In.
Top Ironstone	3	0 3
Clunch	-	3 3
Bottom Ironstone	18	1 6
	21	5 0

3. *Highfields near Bilston.*

	In.	Ft. In.
Ironstone	3	0 3
Clunch	-	1 10
Ironstone	3	0 3
Clunch	-	1 10
Ironstone	6	0 6
	12	4 8

4. *Foxyards near Dudley.*

	In.	Ft. In.
Ironstone	5	0 5
Clunch	-	1 6
Ironstone	1	0 1
Clunch	-	1 3
Ironstone	3	0 3
	9	3 6

5. *Gornal Clay Works.*

	In.	Ft. In.
White Clunch	-	1 6
Ironstone	3	0 3
White Clunch	-	2 0
Dark Clunch	-	1 0
Ironstone	6	0 6
	9	5 3

6. *Corbyn's Hall.*

	In.	Ft. In.
Top Ironstone	9	0 9
Clunch	-	5 6
Bottom Stone	12	1 0
	21	7 3

7. *Dudley Woodside.*

	In.	Ft. In.
Ironstone	2½	0 2½
Clunch, &c.		4 0
Ironstone	3½	0 3½
	6	4 6

8. *Kingswinford Colliery.*

	In.	Ft. In.
Top Ironstone	6	0 6
Measures		6 10
Bottom Ironstone	10	0 10
	16	8 2

In the Pensnett and Cradley basins and in the district around Dudley, as far east as Oldbury and as far north as Ettingshall Lane, this ironstone is almost invariably called the White stone. It is, over that space, almost the lowest stone ever gotten, and the one on which the principal dependence has been placed of late years. North of Ettingshall, about Wolverhampton, Bilston, and Walsall, it is always called the New Mine Stone, and it is there one of the uppermost ironstones, richer and more important beds beginning to set in below it.

VII. "*Pennystone, Bluestone, or Cakes.*"—The beds in which this ironstone lies are dark clay, sometimes black, and generally spoken of as clunch or clod. The ironstone occurs in flat roundish nodules of a dark colour, so as to be readily distinguishable from the white ironstone above it.

In the district to the south-west of Dudley, ironstone has rarely, if ever, been found on this horizon or below it.

It is well known towards Oldbury under the name of Cakes or Bluestone, and between Wolverhampton and Walsall as Pennystone.

Near Oldbury fossil shells are abundant in the upper part of the Cakes and bottom of the Whitestone, both the shells known formerly as Unio and now called Cardinia and

Anthrocosia, and others such as Producta scabricula, Avicula quadrata, Pecten ? unnamed, Lingula mytiloides? Orbicula nitida, Conularia quadrisulcata, also an Echinus probably Archæocidaris, and fish teeth and bones. It is remarkable that the shells called Cardinia are never, or very rarely, mingled in the same mass of stone with any of the other shells, except in rare instances with a solitary Lingula.

VIII. "*FireclayBalls*" *ironstone.*—The measures containing this ironstone are most variable and capricious, and of course the ironstone is equally uncertain in its occurrence. In the Stow Heath and Priestfield collieries between Bilston and Wolverhampton, where there are many pits within the space of half a mile, these measures vary from a seam of clay 2 or 3 feet in thickness, to a mass of sandstone 39 feet thick with a little fireclay above and below it. Wherever the clay predominates and beds of 5 or 6 feet of argillaceous matter occur, there come in occasional balls of ironstone, making a layer sometimes 3 feet in thickness. These are called the Fireclay balls as occurring above the Fireclay coal.

IX. "*Getting Rock*" *ironstone.*—Below the Fireclay coal there is generally from 2 to 10 feet of fireclay, after which a sandstone is frequently met with, sometimes containing balls of ironstone sufficient to be worth getting. It is then called "the Getting Rock." It seems to be confined to the neighbourhood of Stow Heath, Ettingshall, Deepfields, and Bradley, and does not always occur even there.

X. "*Poor Robin*" *ironstone.* — This ironstone is more widely diffused and persistent than that of the Getting Rock. The measure is sometimes three or four feet thick.

XI. "*Rough Hills Whitestone.*"—This ironstone appears to be absolutely confined to the district between Bilston and Wolverhampton. It was first worked at the Rough Hills south of Wolverhampton. At Parkfields the measures were 19 feet 2 inches thick, containing 11 bands of ironstone

from 1 inch to 6 inches thick, making a total of 32 inches of ironstone; but elsewhere it is never more than 3 or 4 feet thick, with not more than 6 or 8 inches of ironstone.

XII. "*Gubbin and Balls*" *ironstone, sometimes called the Bottom or Great Gubbin to distinguish it from* No. V.—This, as a measure containing good workable ironstone, occurs only between Wolverhampton and Walsall, and around Bilston.

At Chillington Colliery it had the following form:—

	In.	Ft. In.
Balls of ironstone	8	0 8
Clod		2 6
Balls of ironstone	6	0 6
Dark clod		1 6
Gubbin ironstone	6	0 6
Clod		1 0
Gubbin ironstone	3	0 3
	23	6 11

The balls are generally distinctly septarian, the septa or internal fissures being lined with crystals of iron pyrites and sometimes with those of galena and blende.

XIII. "*Blue Flats*" *ironstone.*—This ironstone is so called from the flat pavement-like form in which it occurs, together with its weathering of a dull purplish blue after exposure to the atmosphere. It is confined absolutely, as a workable measure, to the district between Wolverhampton and Walsall, being scarcely known south of Bilston on the one hand, nor north of Bloxwich on the other. The following are some detailed accounts of it:—

1. *Park Hall, just South of Wolverhampton.*

	In.	Ft. In.
Topstone	6	0 6
Binds, &c.		2 0
Secondstone	3	0 3
Parting		1 3
Thirdstone	4	0 4
Ground with Chitterstone		4 2
Bottom stone	3	0 3
	16	8 9

2. *Bentley Estate.*

	In.	Ft. In.
Ironstone	4	0 4
Binds		3 0
Ironstone	1	0 1
Binds		1 6
Ironstone	2	0 2
	7	5 1

3. *Ryecroft near Walsall.*

	In.	Ft. In.
Ironstone cake	3	0 3
Blue clod		1 0
Ironstone	3	0 3
	6	1 6

Farther north, at Dudley Brothers colliery and near Pelsall, although the measures have been sunk through and recognized, neither the Blue Flats nor the two following ironstones were found, nor anything but a little "lean" ironstone supposed to represent them.

XIV. "*Silver Threads*" *ironstone.*—This seems to be confined to the district round Walsall. It occurs from 5 to 14 feet below the Blue Flats. The measure consists of clay (binds or clod) from 4 to 7 feet in thickness, containing two or three bands of ironstone each from 1 to 4 inches in thickness. It was named from little threads of shining spar which traversed the ironstone.

XV. "*Diamonds*" *ironstone.*—This was also named from the crystals of spar it contained, which in the miners' eyes resembled diamonds, just as quartz crystals are sometimes spoken of as Bristol or Irish diamonds. It is separated from No. XIV. by from 6 to 15 feet of binds, &c. The measure is from 2 to 4 feet thick (binds or clod), containing two layers of ironstone from 2 to 4 inches each. It is occasionally mentioned as recognisable near Wolverhampton, but as a workable bed it is confined, like the Silver-threads, to the district just west of Walsall.

J. Beete Jukes.

Analyses of Iron Ores—*continued from page* 97.

XXII.—Brooch Ironstone, Corngreaves. (By J. Spiller.)

(No. I. of General Section. *See* pp. 103. and 107.)

Description.—Clay iron ore; colour, greyish brown; fracture, uneven. The ore is uniform in character, with the exception of small tubular cavities filled with white clay, in which zinc-blende occurs.

Analysis by Method No. III.

Water, hygroscopic and total amount:—	Grs.
51·885 grs. of ore lost of water at 100° C.	0·28
37·02 grs. of ore gave of water at a red heat	0·69
By the action of hydrochloric acid—	
15·16 grs. of ore gave of—	
Insoluble residue	2·88
Peroxide of iron (containing 0·07 gr. of silica)	7·45
Alumina	0·16
Manganoso-manganic oxide ($Mn_3 O_4$)	0·16
Sulphate of lime	0·56
Pyrophosphate of magnesia	0·49
The insoluble residue gave of—	
Silica	1·88
Alumina	0·775
Peroxide of iron	0·09
Sulphate of lime	0·055
Ammonio-phosphate of magnesia	trace.
24·21 grs. of ore gave of—	
Organic matter	0·215
Sulphate of potash	0·19
Sulphuric acid and sulphur as pyrites:—	
46·915 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	0·02
Sulphate of baryta (from bisulphide of iron)	0·56
Phosphoric acid:—	
112·79 grs. of ore gave of pyrophosphate of magnesia	1·47
Carbonic acid:—	
I. 33·27 grs. of ore gave of carbonic acid	9·36
II. 27·51 ,, ,,	7·765

Iron by standard solution of permanganate of potash:—

Standard: 1 gr. of iron = 81·76 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. iron.
9·91	29·7	34·20

Results Tabulated.

	I.	II.
Protoxide of iron - -	43·81	43·97
Protoxide of manganese -	0·98	
Alumina - - -	1·05	
Lime - - -	1·52	
Magnesia - - -	1·15	
Carbonic acid - -	28·22	28·13
Phosphoric acid - -	0·83	
Silica, soluble in hydrochloric acid - -	0·46	
Sulphuric acid - - -	trace.	
Bisulphide of iron - -	0·30	
Water, hygroscopic -	0·54	
,, combined - -	1·32	
Organic matter - -	0·88	
Ignited insoluble residue -	18·80	
	99·86	

Ignited Insoluble Residue.

Silica - - -	12·40
Alumina - - -	5·11
Peroxide of iron - -	0·39
Lime - - - -	0·15
Magnesia - - -	trace.
Potash - - -	0·42
	18·47
Iron, total amount - -	34·35

Besides zinc, occurring in the form of blende, a minute trace of a white metal, too small to identify, was found in 460 grains of the ore.

XXIII.—Pins, Dudley. (By A. Dick.)

(No. 181 of the Illustrated Catalogue.—No. II. of General Section. *See* pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish black; structure, compact and homogeneous, with spots of white crystalline matter very sparingly diffused through it.

Analysis chiefly by Method No. III.

Water, hygroscopic and combined :—	grs.
34·16 grs. of ore lost of water at 100° C.	0·12
And gave of water at a red heat	0·56
By the action of hydrochloric acid :—	
17·94 grs. of ore gave of—	
Insoluble residue	2·86
Peroxide of iron	9·01
Manganoso-manganic oxide	0·11
Alumina	0·11
Sulphate of lime	4·13
Pyrophosphate of magnesia	0·60
Silica	0·12
5·67 grs. of insoluble residue gave of—	
Silica	3·65
Alumina	1·82
Peroxide of iron	0·24
Oxalate of lime	trace.
Pyrophosphate of magnesia	0·04
34·06 grs. of ore gave of—	
Organic matter	0·54
Chloride of potassium	0·20
Phosphoric and sulphuric acids, and bisulphide of iron.	
35·42 grs. of ore gave of pyrophosphate of magnesia	0·26
28·80 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
Sulphate of baryta (from bisulphide of iron)	0·24
30·89 grs. of ore gave of carbonic acid	9·30

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	45·35
Protoxide of manganese	0·56
Alumina	0·61
Lime	2·60
Magnesia	1·22
Carbonic acid	30·21
Phosphoric acid	0·46
Sulphuric acid	trace.
Silica	0·67
Bisulphide of iron	0·20
Water	1·64
Organic matter	1·59
Ignited insoluble residue	15·87
	100·98

Ignited Insoluble Residue.

Silica	9·96
Alumina	5·09
Peroxide of iron	0·54
Lime	trace.
Magnesia	0·04
Potash	0·36
	15·99

Iron, total amount	35·74

By treatment of the hydrochloric acid solution of 600 grs. of ore with sulphuretted hydrogen, and reduction before the blowpipe, a trace of whitish metal was obtained. It was too small in quantity to be identified.

XXIV.—Penny Earth, Dudley. (By A. Dick.)

(No. 182 of the Illustrated Catalogue.—No. II. of General Section. See pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish brown; structure, compact and homogeneous.

Analysis by Method No. II.

Water, hygroscopic and combined:—	grs.
39·56 grs. of ore lost of water at 100° C. - - -	0·32
And gave of water at a red heat - - -	0·51
By the action of hydrochloric acid—	
15·21 grs. of ore gave of insoluble residue - -	3·96
The hydrochloric acid solution and the solution of the residue gave of—	
Peroxide of iron - - - - - -	6·36
Manganoso-manganic oxide - - - -	0·10
Alumina - - - - - -	1·25
Sulphate of lime - - - - -	1·00
Pyrophosphate of magnesia - - -	1·08
Silica - - - - - - - -	2·74
41·31 grs. of ore gave of—	
Organic matter - - - - - - -	0·63
Chloride of potassium - - - -	0·28
Phosphoric and sulphuric acids, and bisulphide of iron:—	
59·10 grs. of ore gave of pyrophosphate of magnesia -	0·61
39·57 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - - -	trace.
Sulphate of baryta (from bisulphide of iron) - -	0·35
50·09 grs. of ore gave of carbonic acid - - -	12·88

Results tabulated.—Ore dried at 100° *C.*

Protoxide of iron - - -	37·69
Protoxide of manganese - -	0·61
Alumina - - - -	8·24
Lime - - - -	2·72
Magnesia - - - -	2·60
Potash - - - -	0·43
Carbonic acid - - - -	25·92
Phosphoric acid - - -	0·66
Sulphuric acid - - -	trace.
Silica - - - -	18·11
Bisulphide of iron - - -	0·22
Water - - - -	1·29
Organic matter - - -	1·56
	100·05

Iron, total amount - - -	29·42
Clay, after ignition* - - -	25·51

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 600 grs. of ore was detected.

XXV.—Grains, Dudley. (By A. Dick.)

(No. 187 of the Illustrated Catalogue.—No. IV. of General Section. *See* pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish black; structure, compact and homogeneous. The ore is covered in some places with a thin layer of yellowish white matter.

Analysis by Method No. II.

	grs.
Water, hygroscopic :—	
54·39 grs. of ore lost of water at 100° C. - -	0·12
Water, total amount :—	
58·51 grs. of ore gave of water at a red heat - -	0·76
By the action of hydrochloric acid :—	
26·55 grs. of ore gave of insoluble residue - -	0·91
The hydrochloric acid solution and the solution of the residue gave of—	
Peroxide of iron - - - - - -	16·00
Manganoso-manganic oxide - - - -	0·59
Alumina - - - - -	0·215
Sulphate of lime - - - -	1·42
Pyrophosphate of magnesia - - - -	0·46
Silica - - - - - -	0·56
40·43 grs. of ore gave of—	
Organic matter - - - - -	0·55
Chloride of potassium - - - -	trace.
Phosphoric and sulphuric acids and bisulphide of iron —	
53·06 grs. of ore gave of pyrophosphate of magnesia -	0·58
37·12 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - -	trace.
Sulphate of baryta (from bisulphide of iron) - -	0·53
53·84 grs. of ore gave of carbonic acid - - -	18·94

* Clay means the residue insoluble in hydrochloric acid; it has the composition of fire-clay. In the analyses in which the term *clay* is used as above, no separate analysis of the insoluble residue was made.

Results tabulated. Ore dried at 100° C.

Protoxide of iron - - -	54·12
Protoxide of manganese - -	2·05
Alumina - - - -	0·78
Lime - - - -	2·21
Magnesia - - - -	0·62
Potash - - - -	trace.
Carbonic acid - - -	35·25
Phosphoric acid - - -	0·69
Sulphuric acid - - -	trace.
Silica - - - -	2·11
Bisulphide of iron - - -	0·40
Water - - - -	1·07
Organic matter - - -	1·36
	100·66
Iron, total amount - - -	42·26
Clay, after ignition - - -	3·43

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 900 grs. of ore was detected.

XXVI.—Gubbin Ironstone, Gubbin, Dudley.

(By A. Dick.)

(No. 188 of the Illustrated Catalogue.—No. V. of General Section. *See* pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish black; structure, compact and homogeneous. It contains thin veins of white and reddish brown matter, in which zinc-blende, galena, and copper pyrites occur.

Analysis by Method No. I.

Water hygroscopic and combined :—	grs.
45·70 grs. of ore lost of water at 100° C. - - -	0·14
42·75 grs. of ore gave of water at a red heat - -	0·72
By the action of hydrochloric acid :—	
16·18 grs. of ore gave of—	
Insoluble residue - - - -	2·47
Peroxide of iron - - - -	8·295
Manganoso-manganic oxide - - -	0·25
Alumina - - - - -	0·07
Carbonate of lime - - - -	0·22
Pyrophosphate of magnesia - - -	0·42
Silica - - - - -	0·02
The insoluble residue gave of—	
Silica - - - - -	1·645
Alumina - - - - -	0·705
Peroxide of iron - - - -	0·03
Lime and magnesia - - - -	traces.
45·70 grs. of ore gave of organic matter - - -	0·52
Phosphoric and sulphuric acids and bisulphide of iron :—	
76·78 grs. of ore gave of pyrophosphate of magnesia -	0·90
37·36 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - -	trace.
Sulphate of baryta (from bisulphide of iron) - -	0·11
14·69 grs. of ore gave of carbonic acid - - -	4·46

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	46·30
Protoxide of manganese - -	1·44
Alumina - - - -	0·44
Lime - - - -	0·76
Magnesia - - - -	0·94
Carbonic acid - - -	30·44
Phosphoric acid - - -	0·74
Sulphuric acid - - -	trace.
Silica soluble in acid - - -	0·12
Bisulphide of iron - - -	0·07
Water - - -	1·38
Organic matter - - -	1·14
Ignited insoluble residue - -	15·26
	99·03

Ignited Insoluble Residue.

Silica - - - -	10·17
Alumina - - - -	4·36
Peroxide of iron - - -	0·13
Lime and magnesia - - -	traces.
Potash - - -	undetermined.
	14·66
Iron, total amount - - -	36·14

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 500 grs. of ore was detected.

XXVII.—Gubbin Ironstone, Cannock, Dudley. (By A. Dick.)

(No. 189 of the Illustrated Catalogue.—No. V. of General Section. *See* pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish brown; structure, compact and homogeneous. It contains thin veins of greyish white matter, and blende.

Analysis by Method No. I.

	grs.
Water, hygroscopic and combined :—	
66·14 grs. of ore lost of water at 100° C. -	0·24
and gave of water at a red heat - - -	0·715
By the action of hydrochloric acid.	
19·27 grs. of ore gave of :—	
Insoluble residue - - - -	3·065
Peroxide of iron - - - -	9·74
Manganoso-manganic oxide - - -	0·20
Alumina - - - - -	0·08
Carbonate of lime - - - -	0·41
Pyrophosphate of magnesia - - -	0·87
Silica - - - - -	0·08
The insoluble residue gave of—	
Silica - - - - -	1·98
Alumina - - - - -	1·05
Peroxide of iron - - - -	0·09
Carbonate of lime - - - -	0·07
Pyrophosphate of magnesia - - -	0·11
46·84 grs. of ore gave of organic matter - -	0·43

Phosphoric and sulphuric acids and bisulphide of iron :—

73·45 grs. of ore gave of pyrophosphate of magnesia -	0·24
53·59 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - -	trace.
Sulphate of baryta (from bisulphide of iron) -	0·19
16·66 grs. of ore gave of carbonic acid - - -	5·15

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	45·86
Protoxide of manganese - -	0·96
Alumina - - - -	0·42
Lime - - - -	1·17
Magnesia - - - -	1·65
Carbonic acid - - -	31·02
Phosphoric acid - - -	0·21
Sulphuric acid - - -	trace.
Silica soluble in acid - -	0·42
Bisulphide of iron - - -	0·10
Water - - -	1·08
Organic matter - - -	0·90
Ignited insoluble residue - -	15·90
	99·69

Ignited Insoluble Residue.

Silica - - - -	10·26
Alumina - - - -	5·44
Peroxide of iron - - -	0·40
Lime - - - -	0·20
Magnesia - - - -	0·20
Potash - - -	undetermined.
	16·50

Iron, total amount - - -	35·99

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 500 grs. of ore was detected.

XXVIII.—Gubbin Ironstone, Rubble, Dudley.

(By A. Dick.)

(No. 190 of the Illustrated Catalogue.—No. V. of General Section. *See* pp. 104. and 108.)

Description.—Clay iron ore; colour, greyish black; structure, compact and homogeneous.

Analysis by Method No. I.

	grs.
Water hygroscopic and combined :—	
53·44 grs. of ore lost of water at 100° C. - -	0·19
47·89 grs. of ore lost of water at a red heat - -	0·97
By the action of hydrochloric acid :—	
17·26 grs. of ore gave of	
Insoluble residue - - - -	4·15
Peroxide of iron - - - -	7·68
Manganoso-manganic oxide - - -	0·10
Alumina - - - - -	0·09
Carbonate of lime - - - -	0·26
Pyrophosphate of magnesia - - -	0·63
Silica - - - - -	0·15
The insoluble residue gave of—	
Silica - - - - -	3·14
Alumina - - - - -	0·77
Peroxide of iron - - - -	0·10
Carbonate of lime - - - -	0·21
Pyrophosphate of magnesia - - -	0·07
53·25 grs. of ore gave of organic matter - -	1·04
Phosphoric and sulphuric acid and bisulphide of iron :—	
76·82 grs. of ore gave of pyrophosphate of magnesia -	0·37
50·35 grs. of ore gave of sulphate of baryta (from sulphates)	trace.
30·42 grs. of ore gave of—	
Sulphate of baryta (from bisulphide of iron) - -	0·13
29·16 grs. of ore gave of carbonic acid - - -	7·71

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	40·28
Protoxide of manganese - -	0·54
Alumina - - - -	0·52
Lime - - - -	0·84
Magnesia - - - -	1·33
Carbonic acid - - -	26·53
Phosphoric acid - - -	0·30
Sulphuric acid - - -	trace.
Silica soluble in acid - -	0·87
Bisulphide of iron - - -	0·09
Water - - - -	1·69
Organic matter - - -	1·99
Ignited insoluble residue - -	24·06
	99·04

Ignited Insoluble Residue.

Silica - - - -	18·20
Alumina - - - -	4·46
Peroxide of iron - - -	0·52
Lime - - - -	0·68
Magnesia - - - -	0·14
Potash - - -	undetermined.
	24·00

Iron, total amount - -	31·70

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 500 grs. of ore was detected.

XXIX.—WHITESTONE BIND, DUDLEY. (By J. SPILLER.)

(No. VI. of General Section. *See* pp. 104. and 109.)

Description.—Clay iron ore; colour, pale brown grey; fracture, sub-conchoidal, inclining to rough. The ore has a vein of carbonate of lime in which small crystals of galena occur.

Analysis by Method No. III.

Water, hygroscopic:—	grs.
I. 18·98 grs. of ore lost of water at 100° C.	0·115
II. 25·79 „ „	0·145
Water, total amount:—	
I. 30·01 grs. of ore yielded of water at a red heat	0·67
II. 23·75 „ „	0·57
By the action of hydrochloric acid:—	
15·145 grs. of ore gave of—	
Insoluble residue	5·74
Peroxide of iron (containing 0·025 grs. of silica)	5·215
Alumina	0·02
Manganoso-manganic oxide (Mn_3O_4)	0·12
Carbonate of lime	0·48
(Above converted into sulphate of lime	0·64)
Pyrophosphate of magnesia	1·225
The insoluble residue from 7·705 grs. of ore gave of—	
Silica	2·03
Alumina	0·73
Peroxide of iron	0·095
Oxalate of lime	trace.
Pyrophosphate of magnesia	0·045
34·49 grs. of ore gave of—	
Organic matter	0·035
Sulphate of potash	0·47
Phosphoric and sulphuric acids, and bisulphide of iron:—	
91·80 grs. of ore gave of—	
Pyrophosphate of magnesia	0·375
28·90 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
Sulphate of baryta (from bisulphide of iron)	0·135
Carbonic acid:—	
I. 36·15 grs. of ore gave of carbonic acid	8·00
II. 22·15 „ „	4·86

Additional Determinations by Method of Analysis No. I.

10·50 grs. of ore gave of—	
Insoluble residue	3·92
Carbonate of lime	0·33
Pyrophosphate of magnesia	0·895
14·67 grs. of ore gave of—	
Insoluble residue	5·54
Carbonate of lime	0·48

Results tabulated.

	I.	II.
Protoxide of iron - -	30·96	
Protoxide of manganese -	0·73	
Alumina - - -	0·13	
Lime - - - -	1·84	1·76
Magnesia - - -	2·90	3·03
Carbonic acid - -	22·13	21·94
Phosphoric acid - -	0·26	
Silica, soluble in hydrochloric acid - - -	0·15	
Sulphuric acid - -	trace.	
Bisulphide of iron - -	0·12	
Water, hygroscopic -	0·56	0·60
" in combination -	1·83	1·65
Organic matter - -	0·10	
Ignited insoluble residue -	37·90	37·76
	99·61	

Ignited Insoluble Residue.

Silica - - -	26·35
Alumina - - -	9·45
Peroxide of iron - -	1·15
Lime - - -	trace.
Magnesia - - -	0·21
Potash - - -	0·74
	37·90

Iron, total amount - - 24·88

A trace of lead was found in 300 grains of the ore.

XXX.—Bottom White Stone, Dudley.

(By J. Spiller.)

(No. VI. of General Section. *See* pp. 104 and 109.)

Description.— Clay iron ore, irregularly seamed with numerous small veins of carbonate of lime, which appear in some cases to be in the form of shells; colour, greyish brown; fracture, irregular, being determined by the position of the seams of carbonate of lime. A small quantity of white clay also occurs in the ore.

Analysis by Method No. III.

	grs.
Water, hygroscopic and combined.	
26·785 grs. of ore lost of water at 100° C. - -	0·085
and yielded of water at a red heat - - -	0·33
Water, total amount.	
24·87 grs. of ore gave of water at a red heat - -	0·37
By the action of hydrochloric acid:	
15·11 grs. of ore gave of—	
Insoluble residue - - - -	1·42
Peroxide of iron (containing 0·06 grs. of silica) -	8·225
Alumina - - - - -	0·085
Manganoso-manganic oxide (Mn_3O_4) - -	0·21
Carbonate of lime - - - -	1·20
Pyrophosphate of magnesia - - -	0·34
The insoluble residue from 13·83 grs. of ore gave of—	
Silica - - - - -	0·815
Alumina - - - - -	0·425
Peroxide of iron - - - -	0·02
Oxalate of lime - - } Ammonio-phosphate of magnesia } - -	traces.
23·44 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - -	0·04
Organic matter - - - -	0·065
Chloride of potassium - - -	0·04
Phosphoric acid and sulphur as pyrites.	
115·77 grs. of ore gave of—	
Pyrophosphate of magnesia - - -	0·56
21·15 grs. of ore gave of—	
Sulphate of baryta - - - -	0·135
Carbonic acid.	
I. 33·94 grs. of ore gave of carbonic acid - -	10·86
II. 33·39 „ „ - - -	10·74

Results tabulated.

Protoxide of iron - - -	48·63
Protoxide of manganese - -	1·29
Alumina - - - -	0·57
Lime - - - -	4·45
Magnesia - - -	0·80
Carbonic acid - - - -	32·16
Phosphoric acid - - -	0·31
Silica, soluble in hydrochloric acid -	0·33
Sulphuric acid - - -	0·06
Bisulphide of iron - - -	0·16
Water, hygroscopic - - -	0·32
„ combined - - -	1·23
Organic matter - - - -	0·28
Ignited insoluble residue - -	9·40
	99·99

Ignited Insoluble Residue.

Silica - - - - -	5·88
Alumina - - - - -	3·07
Peroxide of iron - - -	·04
Lime, Magnesia - - - -	traces.
Potash - - - - -	0·11
	9·10

Iron, total amount - - - 37·45

None of the metals, precipitable by sulphuretted hydrogen from the hydrochloric acid solution, were found in 300 grains of the ore.

XXXI.—White Stone, Rough Hay Colliery, Darlaston.

(By C. Tookey.)

(No. VI. of General Section. *See* pp. 104. and 109.)

Description.—Clay iron ore; colour, pale brown grey; structure, compact and very homogeneous; microscopic crystals of copper pyrites occur very sparingly diffused through the ore.

Analysis by Method No. III.

	grs.
Water, hygroscopic :—	
18·985 grs. of ore lost of water at 110° C.	0·08
Water, combined :—	
51·675 grs. of ore dried at 110° C. gave at a red heat	0·51
By the action of hydrochloric acid :—	
27·078 grs. of ore gave of—	
Insoluble residue (ignited)	6·945
Manganoso-manganic oxide	0·225
Alumina	0·185
Sulphate of lime	1·615
Pyrophosphate of magnesia	3·09
Silica	0·025
6·49 grs. of insoluble residue (ignited) gave of—	
Silica	4·59
Alumina	1·46
Peroxide of iron	0·20
Sulphate of lime	0·13
Pyrophosphate of magnesia	0·23
41·775 grs. of ore gave of—	
Organic matter	0·195
56·92 grs. of ore gave of—	
Chloride of potassium in the soluble portion	0·135
,, ,, insoluble portion	0·56
Phosphoric acid :—	
39·55 grs. of ore gave of—	
Pyrophosphate of magnesia	0·22
34·80 grs. of ore gave of—	
Sulphate of baryta (from bisulphide of iron)	0·21
I. 8·74 grs. of ore gave of carbonic acid	2·35
II. 8·822 ,, ,,	2·40
III. 9·91 ,, ,,	2·635

Iron, total amount (soluble) by standard solution of bichromate of potash :—

Standard. 1 gr. of iron = 14·87 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I. 6·95	29·35	28·39
II. 9·63	40·40	28·26
Iron, existing in the state of protoxide :—		
I. 7·40	29·00	26·34
II. 9·235	36·30	26·42

Results tabulated.

Protoxide of iron	33·92
Peroxide of iron	2·77
Protoxide of manganese	0·77
Alumina	0·67
Lime	2·45
Magnesia	4·11
Silica (soluble in hydrochloric acid)	0·09
Potash	0·14
Carbonic acid	26·89
Phosphoric acid	0·35
Bisulphide of iron	0·15
Water, hygroscopic	0·42
,, in combination	0·98
Organic matter	0·47
Ignited insoluble residue	25·55
	99·73

Ignited Insoluble Residue.

Silica	18·14
Alumina	5·77
Peroxide of iron	0·40
Lime	0·20
Magnesia	0·32
Potash	0·60
	25·43

Iron, total amount	28·87

The presence of copper was distinctly proved in 500 grs. of ore; a second experiment on 600 grs. of ore gave the same result.

XXXII.—Cakes, or Blue Stone, Dudley.

(By A. Dick.)

(Nos. 198 and 198*a* of the Illustrated Catalogue.—No. VII. of General Section. *See* pp. 104 and 111.)

Description.—Clay iron ores; colour, greyish brown; structure, compact and homogeneous; containing veins of carbonate of lime.

Analysis by Method No. I.

Water, hygroscopic and combined:—	grs.
30·61 grs. of ore lost of water at 100° C.	0·07
41·39 grs. of ore gave of water at a red heat	0·29
By the action of hydrochloric acid:—	
18·91 grs. of ore gave of—	
Insoluble residue	1·06
Peroxide of iron	10·61
Manganoso-manganic oxide	0·67
Alumina	0·045
Carbonate of lime	0·40
Pyrophosphate of magnesia	1·03
Silica	0·05
1·15 grs. of insoluble residue gave of—	
Silica	0·69
Alumina	0·34
Peroxide of iron	0·10
Carbonate of lime	0·03
Pyrophosphate of magnesia	0·03
Phosphoric and sulphuric acids, and bisulphide of iron:—	
119·60 grs. of ore gave of—	
Pyrophosphate of magnesia	0·44
26·92 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
26·75 grs. of ore gave of—	
Sulphate of baryta (from bisulphide of iron)	0·15
17·35 grs. of ore gave of carbonic acid	6·14

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	50·60
Protoxide of manganese - -	3·30
Alumina - - -	0·24
Lime - - - -	1·19
Magnesia - - - -	1·98
Carbonic acid - - -	35·47
Phosphoric acid - - -	0·23
Sulphuric acid - - -	trace.
Silica, soluble in acid - -	0·27
Bisulphide of iron - - -	0·13
Water - - - -	0·47
Organic matter - -	undetermined.
Ignited insoluble residue -	5·52
	99·40

Ignited Insoluble Residue.

Silica - - - -	3·31
Alumina - - - -	1·63
Peroxide of iron - - -	0·38
Lime - - - -	0·08
Magnesia - - - -	0·06
Potash - - -	undetermined.
	5·46

Iron, total amount - -	39·71

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 200 grs. of ore was detected.

XXXIII.—Cakes, or Blue Stone, Dudley.

(By A. Dick.)

(No. 199 of the Illustrated Catalogue.—No. VII. of General Section. *See* pp. 104. and 111.)

Description.—Clay iron ore; colour, greyish brown; structure, compact and homogeneous. It is coated in some places with a yellowish-white substance.

Analysis by Method No. I.

Water, hygroscopic and combined:—	grs.
45·33 grs. of ore lost of water at 100° C.	0·15
48·45 grs. of ore gave of water at a red heat	0·47
By the action of hydrochloric acid:—	
14·68 grs. of ore gave of—	
Insoluble residue	1·79
Peroxide of iron	7·125
Manganoso-manganic oxide	0·26
Alumina	0·035
Carbonate of lime	0·40
Pyrophosphate of magnesia	1·83
Silica	0·05
The insoluble residue gave of—	grs.
Silica	1·12
Alumina	0·52
Peroxide of iron	0·17
Carbonate of lime	0·06
Pyrophosphate of magnesia	0·04
Phosphoric and sulphuric acids, and bisulphide of iron:—	
87·69 grs. of ore gave of—	
Pyrophosphate of magnesia	0·21
35·16 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	0·06
37·84 grs. of ore gave of—	
Sulphate of baryta (from sulphates and bisulphide of iron)	0·77
36·71 grs. of ore gave of—	
Carbonic acid	12·44

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	43·55
Protoxide of manganese	1·65
Alumina	0·23
Lime	1·53
Magnesia	4·65
Carbonic acid	34·00
Phosphoric acid	0·15
Sulphuric acid	0·06
Silica, soluble in acid	0·34
Bisulphide of iron	0·47
Water	0·64
Organic matter	undetermined.
Ignited insoluble residue	11·95
	99·22

Ignited Insoluble Residue.

Silica	7·47
Alumina	3·47
Peroxide of iron	0·84
Lime	0·19
Magnesia	0·09
Potash	undetermined.
	12·06

Iron, total amount	34·88

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 600 grs. of ore was detected.

XXXIV.—Fire Clay Balls, Dudley. (By A. Dick.)

(Nos. 200 and 201*b* of the Illustrated Catalogue.—No. VIII. of General Section. *See* pp. 104 and 112.)

Description.—Coarse-grained, crystalline carbonates of protoxide of iron, varying in colour from light to dark brown, containing veins of white and reddish-brown matter. 201*b* is lighter in colour, and the veins of white matter are more numerous than in 200.

Analysis by Method No. III.

	grs.
Water, hygroscopic and combined :—	
34·75 grs. of ore lost of water at 100° C. - -	0·13
and gave of water at a red heat - - -	0·515
By the action of hydrochloric acid :—	
17·525 grs. of ore gave of—	
Insoluble residue - - - -	3·23
Manganoso-manganic oxide - - -	0·19
Alumina - - - - -	0·095
Sulphate of lime - - - -	0·44
Pyrophosphate of magnesia - - -	0·64
The insoluble residue gave of—	
Silica - - - - -	2·06
Alumina - - - - -	1·06
Peroxide of iron - - - -	0·12
Carbonate of lime - - - -	0·03
47·55 grs. of ore gave of—	
Organic matter - - - -	0·10
Chloride of potassium - - - -	0·22
Phosphoric and sulphuric acids, and bisulphide of iron :—	
43·68 grs. of ore gave of pyrophosphate of magnesia -	0·13
36·82 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - -	0·13
Sulphate of baryta (from bisulphide of iron) -	0·24
26·37 grs. of ore gave of carbonic acid - -	7·89

Iron by standard solution of bichromate of potash —
Standard : 1 gr. of iron = 8·45 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. iron.
I.	12·49	38·0	35·98
II.	8·47	25·7	35·90

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	46·39
Protoxide of manganese	1·01
Alumina	0·54
Lime	1·03
Magnesia	1·33
Carbonic acid	30·00
Phosphoric acid	0·11
Sulphuric acid	0·10
Bisulphide of iron	0·17
Water	1·50
Organic matter	0·21
Ignited insoluble residue	18·39
	100·78

Ignited Insoluble Residue.

Silica	11·71
Alumina	6·04
Peroxide of iron	0·57
Lime	0·09
Potash	0·28
	18·69

Iron, total amount	36·56

No metal precipitable from the hydrochloric acid solution of 1140 grs. of ore was detected.

XXXV.—Fire Clay Balls, Dudley. (By A. Dick.)

(No. 201*a* of the Illustrated Catalogue.—No. VIII. of General Section. *See* pp. 104 and 112.)

Description.—Fine-grained, crystalline carbonate of protoxide of iron; colour, greyish-brown. It contains veins of calc-spar, and white pulverulent silicate of alumina, in which occur small white crystalline globular concretions, consisting of carbonate of lime and magnesia.

Analysis by Method No. III.

Water, hygroscopic :—	grs.
32·47 grs. of ore lost of water at 100° C.	0·115
Water, total amount :—	
28·09 grs. of ore gave of water at a red heat	0·45
By the action of hydrochloric acid :—	
20·655 grs. of ore gave of —	grs.
Insoluble residue	3·305
Manganoso-manganic oxide	0·26
Alumina	0·09
Sulphate of lime	0·51
Pyrophosphate of magnesia	0·72
The insoluble residue gave of —	
Silica	2·18
Alumina	1·04
Peroxide of iron	0·09
Sulphate of lime	0·05
36·79 grs. of ore gave of —	
Organic matter	0·15
Chloride of potassium	0·22
Phosphoric and sulphuric acids, and bisulphide of iron :—	
32·31 grs. of ore gave of pyrophosphate of magnesia	0·04
35·86 grs. of ore gave of —	
Sulphate of baryta (from sulphates)	0·09
Sulphate of baryta (from bisulphide of iron)	0·24
31·95 grs. of ore gave of carbonic acid	9·86

Iron by standard solution of bichromate of potash :—
Standard: 1 gr. of iron = 8·45 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. iron.
I.	13·95	43·4	36·82
II.	11·185	35·2	37·24

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - - -	47·87
Protoxide of manganese - - -	1·12
Alumina - - - -	0·43
Lime - - - -	1·00
Magnesia - - - -	1·27
Carbonic acid - - -	30·96
Phosphoric acid - - -	0·07
Sulphuric acid - - -	0·08
Bisulphide of iron - - -	0·17
Water - - - -	1·18
Organic matter - - -	0·41
Ignited insoluble residue - -	15·95
	100·51

Ignited Insoluble Residue.

Silica - - - -	10·52
Alumina - - - -	5·02
Peroxide of iron - - -	0·33
Lime - - - -	0·13
Potash - - - -	0·38
	16·38

Iron, total amount - - -	37·47

No metal precipitable from the hydrochloric acid solution of 750 grs. of ore was found.

XXXVI.—Poor Robin's, Bunker's Hill. (By A. Dick.)

(Nos. 203 and 203*a* of the Illustrated Catalogue.—No. X. of General Section. *See* pp. 104 and 112.)

Description.—Clay iron ore; colour, various shades of greyish black; structure, compact. It is seamed with numerous veins of white and yellowish white substance.

Analyis by Method No. III.

Water, hygroscopic and combined :—	grs.
33·87 grs. of ore lost of water at 100° C. - -	0·07
and gave of water at a red heat - - -	0·44
By the action of hydrochloric acid :—	
19·065 grs. of ore gave of—	
Insoluble residue - - - -	1·92
Manganoso-manganic oxide - - -	0·20
Alumina - - - - -	0·09
Sulphate of lime - - - -	0·86
Pyrophosphate of magnesia - - -	0·97
The insoluble residue gave of—	
Silica - - - - -	1·20
Alumina - - - - -	0·45
Peroxide of iron - - - -	0·12
Sulphate of lime - - - -	0·05
50·00 grs. of ore gave of organic matter - -	0·62
34·74 grs. of ore gave of chloride of potassium - -	0·20
Phosphoric and sulphuric acids, and bisulphide of iron :—	
36·95 grs. of ore gave of pyrophosphate of magnesia -	0·20
49·82 grs. of ore gave of—	grs.
Sulphate of baryta (from sulphates) - -	0·14
Sulphate of baryta (from bisulphide of iron) -	0·36

Iron, by standard solution of bichromate of potash :—

Standard: 1 gr. of iron = 8·45 cub. cent. of solution.

Weight of dry ore.	Cub. cent. of solution.	Per cent. iron.
I. 13·56	44·4	38·74
II. 7·39	24·0	38·43

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	49·61
Protoxide of manganese	0·98
Alumina	0·50
Lime	1·86
Magnesia	1·86
Carbonic acid	33·05
Phosphoric acid	0·34
Sulphuric acid	0·10
Bisulphide of iron	0·17
Water	1·30
Organic matter	1·24
Ignited insoluble residue	10·02
	101·03

Ignited Insoluble Residue.

Silica	6·26
Alumina	2·35
Peroxide of iron	0·53
Lime	0·03
Potash	0·39
	9·56

Iron, total amount	39·02

A trace of copper was detected in the hydrochloric acid solution of 1030 grs. of ore.

XXXVII. Rough Hill Whitestone (good sample), Darlaston. (By A. Dick.)

(No. 205 of the Illustrated Catalogue.—No. XI. of General Section. *See* pp. 104 and 112)

Description.—Clay iron ore; colour, brown to greyish black; structure, compact, homogeneous.

Analysis by Method No. II.

	grs.
Water, hygroscopic:—	
38·56 grs. of ore lost of water at 100° C.	0·12
So much tarry matter was evolved when the ore was heated to redness, that an accurate determination of the water combined with the clay could not be made.	
By the action of hydrochloric acid:—	
15·335 grs of ore gave of—	
Insoluble residue	2·635
Peroxide of iron	7·56
Manganoso-manganic oxide	0·40
Alumina	0·06
Sulphate of lime	0·36
Pyrophosphate of magnesia	0·43
Silica	0·15
15·53 grs. of ore gave of organic matter	0·415
Phosphoric and sulphuric acids, and bisulphide of iron:—	
76·95 grs. of ore gave of pyrophosphate of magnesia	0·81
38·29 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	0·08
Sulphate of baryta (from bisulphide of iron)	0·62
22·96 grs. of ore gave of carbonic acid	6·645

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	44·20
Protoxide of manganese	2·43
Alumina	0·37
Lime	0·96
Magnesia	1·04
Carbonic acid	29·03
Phosphoric acid	0·66

Sulphuric acid - - -	0·05
Silica - - - - -	0·98
Bisulphide of iron - - -	0·26
Water - - -	undetermined.
Organic matter - - -	2·68
Ignited insoluble residue - -	17·04
	99·70
Iron, total amount - - -	34·53

XXXVIII. Rough Hill Whitestone (bad sample), Darlaston. (By A. Dick.)

(No. 205 of the Illustrated Catalogue.—No. XI. of General Section. *See* pp. 104. and 112.)

Description.—Clay iron ore, containing shale.

Analysis by Method No. II.

	grs.
Water, hygroscopic and combined:—	
44·58 grs. of ore lost of water at 100° C. - -	0·33
Owing to the large amount of tarry matter produced by heating the ore to low redness, the amount of water combined with the clay could not be determined.	
By the action of hydrochloric acid:—	
20·36 grs. of ore gave of insoluble residue - -	6·21
The hydrochloric acid solution, and the solution of the residue, gave of—	
Peroxide of iron - - - - - -	7·51
Manganoso-manganic oxide - - -	0·44
Alumina - - - - - - -	1·56
Pyrophosphate of magnesia (from phosphoric acid in ore)	0·16
Carbonate of lime - - - - -	0·45
Pyrophosphate of magnesia (from magnesia in ore) -	0·58
Silica - - - - -	4·54
54·05 grs. of ore gave of organic matter about - -	5·29
Chloride of potassium - - - -	0·77
65·52 grs. of ore gave of—	
Sulphate of baryta (from sulphates) - - -	0·08
Sulphate of baryta (from bisulphide of iron) - -	1·04
18·67 grs. of ore gave of carbonic acid - - -	3·88

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	33·19
Protoxide of maganese - -	2·02
Alumina - - - - -	7·71
Lime - - - -	1·24
Magnesia - - - -	1·04
Potash - - - -	0·90
Carbonic acid - - - -	20·94
Phosphoric acid - - -	0·50
Sulphuric acid - - -	0·04
Silica - - - -	22·48
Bisulphide of iron - - -	0·41
Water - - -	undetermined.
Organic matter, about - - -	9·87
	100·34
Iron, total amount - - -	26·01

A trace of copper was detected in 500 grs. of ore.

XXXIX. Rough Hill Whitestone, Rough Hay Colliery, Darlaston. (By C. Tookey.)

(No. XI. of General Section. *See* pp. 104. and 112.)

Description.—Clay iron ore; colour, brown; structure, compact and homogeneous. Veins of hydrated silicate of alumina, peroxide of iron, and copper pyrites occur in it.

Analysis by Method No. III.

Water, hygroscopic (not estimated).

Water, total amount:—	grs.
I. 63·38 grs. of ore gave at a read heat - - - -	0·69
II. 69·19 „ „ - - - -	0·735
By the action of hydrochloric acid:—	
19·155 grs. of ore gave:—	
Insoluble residue (ignited) - - - -	2·655
Manganoso-manganic oxide - - -	0·135
Alumina - - - - - -	0·135
Sulphate of lime - - - - -	0·525
Pyrophosphate of magnesia - - -	0·625
Silica - - - - -	0·105

7·27 grs. of insoluble residue (ignited) gave of—

Silica	4·05
Alumina	2·47
Peroxide of iron	0·29
Sulphate of lime	0·14
Pyrophosphate of magnesia	0·22
Protoxide of manganese	trace.

42·80 grs. of ore gave of—

Organic matter	0·21
Chloride of potassium in the soluble portion	0·155
Chloride of potassium in the insoluble portion	0·555

Phosphoric acid:—

33·505 grs. of ore gave of—

Pyrophosphate of magnesia	0·20

43·05 grs. of ore gave of—

Sulphate of baryta (from bisulphide of iron)	0·23
I. 8·50 grs. of ore gave of carbonic acid	2·56
II. 8·365 grs. ,, ,,	2·515

Iron, total amount (soluble in hydrochloric acid) by standard solution of bichromate of potash:—

Standard: 1 gr. of iron = 14·82 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I.	7·715	43·660	38·14
II.	6·735	38·15	38·22
Iron existing in the state of protoxide:—			
I.	6·915	37·00	36·11
II.	7·07	38·05	36·32

Results tabulated.

Protoxide of iron	46·56
Peroxide of iron	2·80
Protoxide of manganese	0·65
Alumina	0·70
Lime	1·13
Magnesia	1·18
Silica	0·54
Potash	0·23
Carbonic acid	30·08
Phosphoric acid	0·38
Bisulphide of iron	0·13
Water	1·07
Organic matter	0·50
Ignited insoluble residue	13·77
	99·72

Ignited Insoluble Residue.

Silica - - - -	7·72
Alumina - - - -	4·70
Peroxide of iron - - -	0·39
Lime - - - - -	0·11
Magnesia - - - -	0·15
Potash . - - - -	0·82
Protoxide of manganese - -	trace.
	13·89
Iron, total amount - - -	38·56

The presence of copper was distinctly proved in 800 grs. of ore.

XL.—Gubbin and Balls, Bunker's Hill Colliery. (By A. Dick.)

(No. 206 of the Illustrated Catalogue.—No. XII. of General Section. *See* pp. 104 and 113.)

Description.—Clay iron ore; colour, greyish brown; structure, compact, seamed by white pulverulent silicate of alumina, and grey crystalline carbonate of lime.

Analysis by Method No. I.

Water, hygroscopic and combined :—	grs.
37·64 grs. of ore lost of water at 100° C. - -	0·23
and gave of water at a red heat - - -	0·37
By the action of hydrochloric acid :—	
14·935 grs. of ore gave of—	
Insoluble residue - - - - -	3·405
Manganoso-manganic oxide - - -	0·15
Alumina - - - - -	0·165
Sulphate of lime - - - -	0·76
Pyrophosphate of magnesia - - - -	1·12
The insoluble residue gave of—	
Silica - - - - -	2·42
Alumina - - - - -	0·77
Peroxide of iron - - - -	0·13
Oxalate of lime - - - - -	trace.
Pyrophosphate of magnesia - - -	0·12
24·94 grs. of ore gave of—	
Organic matter - - - - -	0·13
Chloride of potassium - - -	0·24

Phosphoric and sulphuric acids, and bisulphide of iron :—

44·96 grs. of ore gave of pyrophosphate of magnesia	0·22
38·65 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
Sulphate of baryta (from bisulphide of iron)	0·10
22·16 grs. of ore gave of carbonic acid	6·17

Iron by standard solution of bichromate of potash :—

Standard : 1 gr. of iron = 8·44 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. iron.
I. 8·40	21·6	30·45
II. 9·25	23·8	30·48

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	39·51
Protoxide of manganese	0·94
Alumina	1·12
Lime	2·11
Magnesia	2·76
Carbonic acid	28·08
Phosphoric acid	0·31
Sulphuric acid	trace.
Bisulphide of iron	0·05
Water	0·98
Organic matter	0·52
Ignited insoluble residue	22·96
	99·34

Ignited Insoluble Residue.

Silica	16·31
Alumina	5·13
Peroxide of iron	0·85
Lime	trace.
Magnesia	0·30
Potash	0.65
	23·24

Iron, total amount	31·34

A minute trace of lead was detected in 740 grs. of the ore.

XLI.—Gubbin and Balls, Bunker's Hill Colliery.

(By A. Dick.)

(No. 207 of the Illustrated Catalogue.—No. XII. of General Section. *See* pp. 104. and 113.)

Description.—Clay iron ore; colour, greyish brown; structure, compact. It contains veins of greyish white pulverulent silicate of alumina, and traces of galena.

Analysis by Method No. III.

Water, hygroscopic and combined :—	grs.
48·63 grs. of ore lost of water at 100° C.	0·19
and gave of water at a red heat	0·225
By the action of hydrochloric acid :—	
11·61 grs. of ore gave of—	grs.
Insoluble residue	1·30
Manganoso-manganic oxide	0·115
Alumina	0·15
Sulphate of lime	0·15
Pyrophosphate of magnesia	0·27
The insoluble residue gave of—	
Silica	0·785
Alumina	0·43
Peroxide of iron	0·06
Oxalate of lime	trace.
Pyrophosphate of magnesia	0·10
44·78 grs. of ore gave of—	
Organic matter	0·23
Chloride of potassium	0·23
Phosphoric and sulphuric acids, and bisulphide of iron :—	
40·76 grs. of ore gave of pyrophosphate of magnesia	0·14
43·59 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
Sulphate of baryta (from bisulphide of iron)	0·23
28·99 grs. of ore gave of carbonic acid	9·33

Iron by standard solution of bichromate of potash :—
Standard: 1 gr. of iron=8·84 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. iron.
I. 10·47	35·7	40·39
II. 9·48	32·2	40·24

Results tabulated.—Ore dried at 100° C.

Protoxide of iron - - -	52·04
Protoxide of manganese - -	0·92
Alumina - - - -	1·30
Lime - - - -	0·53
Magnesia - - - -	0·85
Carbonic acid - - -	32·31
Phosphoric acid - - -	0·21
Sulphuric acid - - -	trace.
Bisulphide of iron - - -	0·13
Water - - - -	0·46
Organic matter - - -	0·51
Ignited insoluble residue - -	11·14
	100·40

Ignited Insoluble Residue.

Silica - - - -	6·63
Alumina - - - -	3·68
Peroxide of iron - - -	0·43
Lime - - - -	trace.
Magnesia - - - -	0·33
Potash - - - -	0·32
	11·39

Iron, total amount - - -	40·84

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 720 grs. of ore was detected.

XLII.—Gubbin and Balls, Balls, Rough Hay Colliery, Darlaston. (By C. Tookey.)

(No. XII. of General Section. *See* pp. 104 and 113.)

Description. — Clay iron ore ; colour, greyish black ; structure, compact. It is seamed with veins of greyish white silicate of alumina, in which minute crystals of zinc-blende, iron pyrites, and copper pyrites occur.

Analysis by Method No. III.

	grs.
Water hygroscopic :—	
27·00 grs. of ore lost at 110° C. - - -	0·07
Water total amount :—	
I. 59·67 grs. of ore gave at a red heat - - -	0·61
II. 49·495 grs. of ore ,, - - - -	0·51
By the action of hydrochloric acid :—	
18·83 grs. of ore gave of—	
Insoluble residue (ignited) - - -	2·30
Manganoso-manganic oxide - - -	0·16
Alumina - - - - -	0·04
Sulphate of lime - - - -	0·32
Pyrophosphate of magnesia - - -	0·30
Silica - - - - - -	0·05
7·07 grs. of insoluble residue (ignited) gave of—	
Silica - - - - -	4·44
Alumina - - - - -	2·055
Peroxide of iron - - - -	0·25
Sulphate of lime - - - - -	0·13
Pyrophosphate of magnesia - - -	0·15
Protoxide of manganese - - - -	trace.
52·855 grs. of ore gave of—	
Organic matter - - - - -	0·315
Chloride of potassium in the portion soluble in acid -	0·09
Chloride of potassium in the portion insoluble in acid -	0·27
Phosphoric acid.	
38·745 grs. of ore gave of—	
Pyrophosphate of magnesia - - -	0·11
54·59 grs. of ore gave of—	
Sulphate of baryta (from bisulphide of iron) - -	0·20
I. 7·30 grs. of ore gave of carbonic acid - - -	2·255
II. 9·035 grs. of ore gave of carbonic acid - - -	2·775

Iron, total amount (soluble in hydrochloric acid) by standard solution of bichromate of potash.

Standard : 1 gr. of iron=14·82 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I.	6·565	39·30	40·40
II.	8·315	50·05	40·63
Iron existing in the state of protoxide.			
I.	6·68	37·70	38·08
II.	4·945	28·00	38·21

Results tabulated.

Protoxide of iron - - -	49·04
Peroxide of iron - - -	3·39
Protoxide of manganese - -	0·79
Alumina - - - -	0·21
Lime - - - -	0·70
Magnesia - - - -	0·57
Silica, soluble in hydrochloric acid -	0·27
Potash - - - -	0·10
Carbonic acid - - -	30·80
Phosphoric acid - - -	0·18
Bisulphide of iron - - -	0·11
Water, hygroscopic - - -	0·26
" in combination - -	0·77
Organic matter - - -	0·60
Ignited insoluble residue - -	12·15
	99·94

Ignited Insoluble Residue.

Silica - - - -	7·67
Alumina - - - -	3·55
Peroxide of iron - - -	0·36
Lime - - - -	0·09
Magnesia - - - -	0·09
Potash - - - -	0·32
Protoxide of manganese - -	trace.
	12·08

Iron, total amount - - -	40·81

The presence of copper was distinctly proved in 800 grs. of ore.

XLIII.—Gubbin and Balls, Gubbin, Rough Hay Colliery, Darlaston. (By C. Tookey.)

(No. XII. of General Section. *See* pp. 104. and 113.)

Description.—Clay iron ore; colour, greyish black; structure, compact. It contains white pulverulent silicate of alumina, a large quantity of zinc-blende and minute crystals of iron pyrites.

Analysis by Method No. III.

	grs.
Water, hygroscopic,	
25·62 grs. of ore lost of water at 110° C.	0·095
Water, combined.	
83·71 grs. of ore dried at 110° C. gave at a red heat	0·25
By the action of hydrochloric acid :	
25·62 grs. of ore gave of—	
Insoluble residue (ignited)	2·435
Manganoso-manganic oxide	0·235
Alumina	0·065
Silica	0·06
Sulphate of lime	0·425
Pyrophosphate of magnesia	0·32
The insoluble residue (ignited) gave of—	
Silica	1·535
Alumina	0·695
Peroxide of iron	0·075
Sulphate of lime	0·105
Pyrophosphate of magnesia	0·05
70·485 grs. of ore gave of—	
Organic matter	0·38
Chloride of potassium from soluble portion	0·10
Chloride of potassium from insoluble portion	0·17
Phosphoric acid.	
33·307 grs. of ore gave of—	
Pyrophosphate of magnesia	0·12
Sulphur.	
36·743 grs. of ore gave of—	
Sulphate of baryta, from sulphide of zinc and bisulphide of iron	1·295
I. 12·80 grs. of ore gave of carbonic acid	4·095
II. 8·92 " "	2·865
Zinc.	
47·15 grs. of ore gave of oxide of zinc	0·50

Iron, total amount (soluble) by standard solution of bichromate of potash.

Standard : 1 gr. of iron = 14·87 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I. 6·91	42·00	40·86
II. 9·14	55·55	40·86
Iron existing in the state of protoxide.		
I. 8·31	47·35	38·31
II. 10·69	61·00	38·36

Results tabulated.

Protoxide of iron	49·30
Peroxide of iron	3·61
Protoxide of manganese	0·86
Alumina	0·34
Lime	0·69
Magnesia	0·45
Silica	0·23
Potash	0·09
Carbonic acid	32·05
Phosphoric acid	0·23
Bisulphide of iron	0·13
Sulphide of zinc	1·27
Hygroscopic water	0·37
Combined ,,	0·29
Organic matter	0·54
Ignited insoluble residue	9·42
	99·87

Ignited Insoluble Residue.

Silica	5·99
Alumina	2·71
Peroxide of iron	0·21
Lime	0·17
Magnesia	0·07
Potash	0·21
	9·36

Iron, total amount	41·06

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 400 grains of ore was detected.

The zinc was determined by digesting the ore with nitro-hydrochloric acid; the solution was nearly neutralized with carbonate of soda, and the peroxide of iron separated by boiling with acetate of soda; the filtrate was saturated with sulphuretted hydrogen and the sulphide of zinc dissolved

in hydrochloric acid; the oxide was precipitated by carbonate of soda from the boiling solution, ignited, and weighed.

XLIV.—Blue Flats Ironstone, Rough Hay Colliery, Darlaston. (By C. Tookey.)

(No. XIII. of General Section. *See* pp. 104. and 113.)

Description.—Clay iron ore; colour, various shades of pale brown. The ore is irregularly seamed with veins of calc-spar, with greyish white and reddish brown silicate of alumina, containing minute crystals of iron pyrites.

Analysis by Method No. III.

Water, hygroscopic.	
13·90 grs. of ore lost of water at 110° C.	0·04
Water, combined.	
54·19 grs. of ore dried at 110° C. gave at a red heat	0·40
By the action of hydrochloric acid:	
14·09 grs. of ore gave of—	
Insoluble residue (ignited)	2·19
Manganoso-manganic oxide	0·17
Alumina	0·084
Silica	0·05
Sulphate of lime	1·33
Pyrophosphate of magnesia	0·58
The insoluble residue gave of—	
Silica	1·525
Alumina	0·515
Peroxide of iron	0·045
Protoxide of manganese	trace.
Lime and magnesia	traces.
43·22 grs. of ore gave of—	
Organic matter	0·24
Chloride of potassium	0·575
51·74 grs. of ore gave of—	
Pyrophosphate of magnesia	0·20
Sulphate of baryta, from bisulphide of iron	0·13
I. 13·325 grs. of ore gave of carbonic acid	4·12
II. 7·00 ,, ,,	2·145

Iron, total amount (soluble) by standard solution of bichromate of potash.

Standard: 1 gr. of iron = 6·86 cub. cent. of solution.

Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I. 19·685	46·10	34·12
II. 19·220	45·20	34·26

Iron, existing in the state of protoxide.

17·45	39·45	32·93

Results tabulated.

Protoxide of iron - - -	42·34
Peroxide of iron - - -	1·47
Protoxide of manganese - -	1·12
Alumina - - - -	0·59
Lime - - - -	3·89
Magnesia - - - -	1·48
Silica - - - -	0·35
Carbonic acid - - -	30·91
Phosphoric acid - - -	0·25
Sulphuric acid - - -	trace.
Bisulphide of iron - - -	0·06
Hygroscopic water - - -	0·28
Combined „ - - -	0·73
Organic matter - - -	0·56
Ignited insoluble residue - -	15·50
	99·53

Ignited Insoluble Residue.

Silica - - -	10·82
Alumina - - - -	3·65
Peroxide of iron - - -	0·11
Protoxide of manganese - -	trace.
Lime and magnesia - -	traces.
Potash - - - -	0·84
	15·42

Iron, total amount - - 34·41

No metal precipitable by sulphuretted hydrogen in the hydrochloric acid solution was found in 400 grs. of the ore.

XLV. Silver Threads, Rough Hay Colliery, Darlaston.

(By C. Tookey.)

(No. XIV. of General Section. *See* pp. 104. and 114.)

Description.—Clay iron ore; colour, greyish brown. The ore is irregularly seamed with numerous veins of calc-spar, coated with drab coloured ferruginous matter.

Analysis by Method No. III.

Water, hygroscopic:—	
19·165 grs. of ore lost of water at 110° C	0·065
Water combined:—	
48·80 grs. of ore dried at 110° C gave at a red heat	0·285
By the action of hydrochloric acid:—	
19·165 grs. of ore gave of—	
Insoluble residue (ignited)	2·035
Manganoso-manganic oxide	0·155
Alumina	0·036
Sulphate of lime	3·41
Pyrophosphate of magnesia	1·15
Silica	0·035
6·87 grs. of insoluble residue (ignited) gave of—	
Silica	4·26
Alumina	2·00
Peroxide of iron	0·24
Sulphate of lime	0·06
Pyrophosphate of magnesia	0·10
Protoxide of manganese	trace.
51·665 grs. of ore gave of—	
Organic matter	0·41
Chloride of potassium, soluble ·115, insoluble ·225	0·34
Phosphoric acid:	
44·35 grs. of ore gave of—	
Pyrophosphate of magnesia	0·15
Sulphuric acid and bisulphide of iron:—	
35·587 grs. of ore gave of sulphate of baryta	trace.
60·135 grs. of ore gave of—	
Sulphate of baryta from bisulphide of iron	0·25
I. 12·836 grs. of ore gave of carbonic acid	4·285
II. 11·825 grs. „ „	3·94

Iron, total amount (soluble) by standard solution of bichromate of potash:—

Standard: 1 gr. of iron = 14·87 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I.	10·695	52·50	33·00
II.	9·975	49·25	33·19
Iron existing in the state of protoxide:—			
	9·69	45·30	31·42

Results tabulated.

Protoxide of iron - - -	40·39
Peroxide of iron - - - -	2·38
Protoxide of manganese - -	0·75
Alumina - - - -	0·19
Lime - - - -	7·30
Magnesia - - - -	2·16
Silica soluble in hydrochloric acid -	0·18
Potash - - - -	0·07
Carbonic acid - - - -	33·35
Phosphoric acid - - -	0·22
Bisulphide of iron - - -	0·11
Hygroscopic water - - -	0·33
Combined water - - -	0·60
Organic matter - - -	0·80
Ignited insoluble residue - -	10·52
	99·35

Ignited Insoluble Residue.

Silica - - - -	6·56
Alumina - - - -	3·08
Peroxide of Iron - - -	0·37
Lime - - - - -	0·04
Magnesia - - - -	0·06
Potash - - - -	0·26
Protoxide of manganese - -	trace.
	10·37

Iron, total amount - - -	33·44

No metal precipitable from the hydrochloric acid solution by sulphuretted hydrogen was detected in 600 grs. of ore.

XLVI. Diamonds, Rough Hay Colliery, Darlaston.

(By C. Tookey.)

(No. XV. of General Section. *See* pp. 104. and 114.)

Description.—Clay iron ore; colour, dark grey; structure, compact and homogeneous. It contains veins of calc-spar, and silicate of alumina in which galena, zinc-blende, copper pyrites, and iron pyrites occur.

Analysis by Method No. III.

Water, hygroscopic.	
15·285 grs. of ore lost at 110° C - - -	0·06
Water, total amount.	
I. 65·80 grs. of ore gave at a red heat - - -	0·725
II. 47·45 " " - - - -	0·54
By the action of hydrochloric acid:	
37·735 grs. of ore gave of—	
Insoluble residue (ignited) - - -	7·10
Manganoso-manganic oxide - - -	0·305
Alumina - - - - - -	0·175
Sulphate of lime - - - - -	2·36
Pyrophosphate of magnesia - - -	2·83
Silica - - - - - -	0·10
The insoluble residue (ignited) gave of—	
Silica - - - - - -	5·06
Alumina - - - - - -	2·075
Peroxide of iron - - - - -	0·24
Sulphate of lime - - - - -	0·075
Pyrophosphate of magnesia - - -	0·15
Protoxide of manganese - - - -	trace.
42·875 grs. of ore gave of—	
Organic matter - - - -	0·47
Chloride of potassium in the portion soluble in acid -	0·13
Chloride of potassium in the portion insoluble - -	0·34
Phosphoric acid.	
55·595 grs. of ore gave of—	
Pyrophosphate of magnesia - - -	0·18
42·39 grs. of ore gave of—	
Sulphate of baryta (from bisulphide of iron) - -	0·105
I. 8·79 grs. of ore gave of carbonic acid - - -	2·56
II. 11·39 " " - - - -	3·32

Iron, total amount (soluble in hydrochloric acid) by standard solution of bichromate of potash:

Standard: 1 gr. of iron = 14·82 cub. cent. of solution.

	Weight of ore.	Cub. cent. of solution.	Per cent. of iron.
I.	8·865	43·05	32·77
II.	7·155	34·90	32·91
Iron existing in the state of protoxide:			
	6·245	28·80	31·12

Results tabulated.

Protoxide of iron - - -	40·01
Peroxide of iron - -	2·46
Protoxide of manganese - -	0·75
Alumina - - - - -	0·46
Lime - - - - - -	2·58
Magnesia - - - -	2·70
Silica - - - - -	0·27
Potash - - - -	0·19
Carbonic acid - - - -	29·13
Phosphoric acid - - -	0·21
Water, hygroscopic - - -	0·39
,, in combination - - -	0·72
Bisulphide of iron - - -	0·06
Organic matter - - -	1·06
Ignited insoluble residue - -	18·77
	99·76

Ignited Insoluble Residue.

Silica - - - -	13·45
Alumina - - - -	4·22
Peroxide of iron - - -	0·59
Lime - - - -	0·08
Magnesia - - - -	0·14
Potash - - - -	0·18
Protoxide of manganese - -	trace
	18·66

Iron, total amount - - -	33·28

Traces of lead and copper were found in the hydrochloric acid solution of 800 grs. of ore.

XLVII.—Diamonds, Darlaston. (By A. Dick.)

(No. 211 *a*. of the Illustrated Catalogue.—No. XV. of General Section. *See* pp. 104. and 114.)

Description. — Clay iron ore; colour, dark greyish brown. Structure, compact and homogeneous. It is seamed with a white powder (XLVIII.) and carbonate of lime, in which minute crystals of zinc-blende occur.

Analysis by Method No. II.

	grs.
Water, hygroscopic and combined.	
56·88 grs. of ore lost of water at 100° C.	0·24
39·62 grs. of ore gave of water at a red heat	0·49
By the action of hydrochloric acid.	
19·16 grs. of ore gave of insoluble residue	2·80
The hydrochloric acid solution and the solution of the residue gave of—	
Peroxide of iron	8·96
Manganoso-manganic oxide	0·15
Alumina	1·00
Sulphate of lime	1·61
Pyrophosphate of magnesia	2·56
Silica	1·90
33·24 grs. of ore gave of—	
Organic matter	0·14
Chloride of potassium	0·46
Phosphoric and sulphuric acids and bisulphide of iron.	
54·53 grs. of ore gave of pyrophosphate of magnesia	0·19
49·93 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	0·09
Sulphate of baryta (from bisulphide of iron)	1·08
50·93 grs. of ore gave of carbonic acid	16·20

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	41·90
Protoxide of manganese	0·72
Alumina	5·26
Lime	3·47
Magnesia	4·89
Potash	0·87
Carbonic acid	31·94
Phosphoric acid	0·22
Sulphuric acid	0·06

Silica - - - -	9·95
Bisulphide of iron - - -	0·56
Water - - - -	0·82
Organic matter - - -	0·42
	101·08
Iron, total amount - - -	32·87
Clay, after ignition - -	14·67

No metal precipitable by sulphuretted hydrogen, from the hydrochloric acid solution of 740 grs. of ore was detected.

XLVIII.—White Substance occurring in Diamonds. (By A. Dick.)

Description.—Hydrated silicate of alumina. It occurs in veins as a white powder, accompanied with calc-spar.

Analysis by Method No. I.

5·45 grs. lost of water over sulphuric acid - - -	0·015
6·89 grs. lost of water by ignition - - - -	1·00
and by the action of hydrochloric acid gave of—	
Insoluble residue - - - - -	3·47
Alumina - - - - - -	2·03
Peroxide of iron - - - - -	0·31
Sulphate of lime - - - - -	0·05
Silica soluble in acid - - - -	0·02
The insoluble residue gave of—	
Silica - - - - - -	2·85
Alumina - - - - - -	0·52
Sulphate of lime - - - - -	0·03
Pyrophosphate of magnesia - - - -	0·03

Results tabulated.—Substance dried over sulphuric acid.

Water - - - -	14·26
Alumina - - - -	29·54
Peroxide of iron - - -	4·51
Lime - - - -	0·30
Silica soluble in acid - -	0·29
Residue insoluble in hydrochloric acid	50·51
	99·41

Ignited Insoluble Residue.

Silica - - - -	41·49
Alumina - - - -	7·45
Lime - - - -	0·18
Magnesia - - - -	0·16
	49·28

Alkalies were not sought for.

XLIX.—Brown Stone, Bloxwich. (By A. Dick.)

(No. 212 of the Illustrated Catalogue.—*See* Note to p. 104. and p. 109.)

Description.—Clay iron ore; colour, various shades of light brown; structure, compact. Veins of white pulverulent and grey crystalline substances occur in it, containing traces of galena and copper pyrites.

Two varieties of ironstone were labelled "Bloxwich" in the Great Exhibition Catalogue, numbered 212 and 213 respectively. Number 213 is a "Blackband ironstone," of which no complete analysis has been made. It is brown-black streaked with brown. It was found to contain 25·34 per cent. of metallic iron, and not less than 30·17 of organic matter. In the Illustrated Catalogue it is stated that "this is the only measure of Blackband in the South Staffordshire coalfield. It lies underneath the lowest Heathen Coal in two courses, averaging about 12 inches, and does not prove south of Bentley. There is also an ironstone called "Brownstone," which occasionally occurs near Dudley, underneath the "Gubbin-Rubble" (Illus. Cat. p. 152.), but no analysis or examination of this variety has been made.

Analysis by Method No. II.

	grs.
Water hygroscopic and combined :—	
49·14 grs. of ore lost of water at 100° C. - - -	0·24
and gave of water at a red heat - - -	0·46
By the action of hydrochloric acid :—	
19·89 grs. of ore gave of insoluble residue - - -	2·65

The hydrochloric acid solution and the solution of the residue gave of—

Peroxide of iron	10·17
Manganoso-manganic oxide	0·30
Alumina	0·70
Sulphate of lime	1·65
Pyrophosphate of magnesia	1·16
Silica	1·71
34·74 grs. of ore gave of—	
Organic matter	0·34
Chloride of potassium	0·23
Phosphoric and sulphuric acids, and bisulphide of iron :—	
27·95 grs. of ore gave of pyrophosphate of magnesia	0·27
32·54 grs. of ore gave of—	
Sulphate of baryta (from sulphates)	trace.
Sulphate of baryta (from bisulphide of iron)	0·13
30·39 grs. of ore gave of carbonic acid	9·66

Results tabulated.—Ore dried at 100° C.

Protoxide of iron	46·14
Protoxide of manganese	1·40
Alumina	3·53
Lime	3·43
Magnesia	2·13
Potash	0·41
Carbonic acid	32·04
Phosphoric acid	0·61
Sulphuric acid	trace.
Silica	8·63
Bisulphide of iron	0·10
Water	0·94
Organic matter	0·98
	100·34
Iron, total amount	35·95
Clay, after ignition	13·38

No metal precipitable by sulphuretted hydrogen from the hydrochloric acid solution of 550 grains of ore was detected.

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LIST OF GEOLOGICAL MAPS AND SECTIONS OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM,

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61 NE. Part of Shropshire and Staffordshire.
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61 SE. Part of Shropshire.
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73 SW. Part of Shropshire.
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74 SW. Part of Montgomery, Denbigh, and Merioneth.
74 SE. Part of Shropshire, Montgomery, and Denbigh.
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75 NE. Part of Caernarvon, Merioneth, and Denbigh.
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